Hydrogeochemistry of Submarine Groundwater Discharge in A Volcanic Coastal Area: Mabini Peninsula, The Philippines

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Submarine Groundwater Discharge (SGD) delivers water and transports chemicals to the ocean. It has an essential role in the global geochemical cycle and on coastal water quality. There is an increasing number of studies exploring SGD in different parts of the globe, but only a few have been done in active volcanic coastal areas. It is important to study SGD in this setting because volcanic coastal areas are common and host environmentally and economically vital coastal ecosystems. This study examined SGD in a volcanic coastal region of the Mabini Peninsula in the Philippines, which has been noted as the center of the world's reef biodiversity. We aim to understand the hydrogeochemistry of SGD and identify the processes behind it. We collected SGD samples at various depths, ranging from the intertidal zone to ~200 ft underwater. We find that the springs emit warm, acidic waters (~50°C, pH ~5.5-6.5) with high dissolved CO_2 (P_{CO2} ~14,000-54,000 ppm). There is no observed correlation between the spring water depth and pH and P_{CO2}. The warmer temperature suggests that thermal convection driven by a volcanic heat source is a significant driver of SGD in the area. Meanwhile, high P_{CO2} signifies inputs of magmatic volatiles. The hydrogen and oxygen isotope composition of the springs indicate that the spring waters are a mixture of three end-members: terrestrial groundwater, recirculated seawater, and hydrothermal water. Intertidal and shallow springs have an approximately equal proportion of groundwater and hydrothermal water at ~40% each; deeper ones are mostly dominated by SW (>50%); and there are two springs that mainly consist of hydrothermal waters (~70%). Major ions were analyzed and interpreted using various plots, including: a mixing diagram with the three end-members, Giggenbach diagram for geothermal solute equilibria, and basic log-log compositional diagram of potential host rocks vs the waters. The mixing plots reveal that most spring waters are outside the mixing triangle, which implies low-temperature water-rock interaction. The geothermal solute equilibria diagram reveals that the spring waters consist of weakly to moderately mineralized solutions, but none of them correspond to either water-rock equilibrium or rock dissolution. Due to the similarity in geology, tectonic setting, and hydro-climatology, this study might represent many other volcanic areas in South East Asia within the Coral Triangle.

Keywords: submarine groundwater discharge, geochemistry, water mixing, water-rock interaction

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